

**Science Applications, Inc.**

One Continental Plaza, Suite 310  
101 Continental Boulevard  
El Segundo, California 90245

SURVEY OF HEAVY-DUTY DIESEL  
MAINTENANCE PRACTICES

EXECUTIVE SUMMARY

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PREPARED BY:

D. F. HAUSKNECHT  
I. B. OSOFSKY

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STATE OF CALIFORNIA  
AIR RESOURCES BOARD  
SACRAMENTO, CALIFORNIA 95812



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## SURVEY OF HEAVY-DUTY DIESEL MAINTENANCE PRACTICES - EXECUTIVE SUMMARY

In California, as in most of the U.S., heavy-duty, diesel-powered vehicles constitute an important and very active segment of the transportation industry. For California this is evidenced by the large quantities of diesel fuel sold in the State. (Over 1.1 billion gallons in 1980). It is commonly accepted that well over 90% of the diesel fuel is used in heavy-duty vehicles, although an exact figure is not available.

California certifies diesel engines to assure compliance with emission standards. The current standards are 1.0 gram per brake horsepower-hour (g/bhp-hr) hydrocarbons (HC), 25 g/bhp-hr carbon monoxide (CO) and 6.0g/bhp-hr HC plus oxides of nitrogen ( $\text{NO}_x$ ). The 1980 results for California Certification of diesels were obtained from 13-mode dynamometer testing. For 16 engine families, the HC, CO and  $\text{NO}_x$  emissions were 0.5, 2.2 and 4.76 g/bhp-hr, respectively. These emission rates are presently acceptable, but more stringent standards of 0.5 g/bhp-hr for HC, and 4.5 g/bhp-hr for HC plus  $\text{NO}_x$  are set for 1984. However, there is presently no means for assuring the engine certification values are at or near the emissions actually emitted by vehicles after they have been in use for some time.

As the emissions from light-duty vehicles are more stringently controlled, the emissions, especially  $\text{NO}_x$  and particulates, from heavy-duty diesels may become a more significant component of the air pollution problem. It is the purpose of this study to develop information and data to enable the California Air Resources Board (ARB) to effectively assess the potential benefits of an inspection program for heavy-duty diesel vehicles (HDDV) and to define some alternatives for a program of this type. For this study, HDDV are diesels with 6001 pounds or greater gross vehicle weight ratings (GVWR). Specifically the objectives of this study are to:

- Determine the number of fleet operations in California.
- Estimate the annual average vehicle miles by class of vehicle.
- Determine what constitutes routine and major maintenance practices and their costs.
- Define and evaluate realistic alternative I/M programs.

Computer and paper registration files of the California Department of Motor Vehicles (DMV) were utilized to obtain data on vehicle types, fleet sizes, ownership and other factors of interest. These files contained the registrations of HDDV based in California as well as those from other states with permits (pro-rated) to operate in California.

A questionnaire was prepared by SAI and reviewed by ARB. It addressed the areas of the number of vehicles owned, type, age, GVWR classification, usage, and maintenance practices and costs. Over 150 of the questionnaires were mailed to a stratified sample of registered owners selected from those based in California (approximately 100) and those based in other states (approximately 50). Follow-up telephone contacts were used, whenever a response was not received or was incomplete or confusing. A total of about 60 questionnaires with varying degrees of completeness were finally collected. Supplemental information on usage and maintenance was gathered through visits and discussions with maintenance personnel, the California State Board of Equalization, the Public Utilities Commission, DMV and others.

There are nearly 210,000 heavy-duty diesel powered vehicles base-plated in California and about 34,000 base-plated in other states, but registered to operate part of the time in California. Of the 210,000 based in California 93,400 are also pro-rated, meaning that they operate in other states, as well as in California.

There are a wide variety of types and sizes of registered vehicles, but the three most prevalent are tractors at 73%, buses at 6.5% and dump trucks at 6%. Each of the other types are 3% or less. For California based tractors, 62% are pro-rated, while only 42% of the buses are. Virtually none of the other types of vehicles base-plated in California are pro-rated. Most of the heavy-duty diesels had GVWR over 19,500 pounds.

Smaller fleets (consisting of 50 or fewer vehicles) were an order of magnitude more numerous than all the larger ones. In contrast a few large fleets have thousands of diesel powered vehicles. Identifiable owner-operators of heavy-duty diesels numbered almost 3800, but the actual number is many times higher. A large number of individual

owner-operators act as agents for large van lines or otherwise under an umbrella organization for business purposes. Registration may occur under a common company name, but the vehicle maintenance and aspects of their usage may not be similar.

Over 50% of the California-based diesels were four years old or less, and 12% were ten years old or more. Bus fleets owned by school or transit districts typically had at least some older units ranging up to 20 years old or more.

Annual mileage for school and transit district buses ranged from roughly 10,000 to over 50,000 miles annually with the school buses reporting the lower mileage and transit district buses the higher. Cross-country bus fleets reported 12,000 to 140,000 miles per year with the high value being the annual mileage of a large fleet of about 2000 buses. The annual mileage reported for tractors and vans shows a wide range of values depending on useage. However, for the numerically prevalent large vehicles (over 19,500 pounds) the annual mileage commonly reported was in the 50,000 to 100,000 mile range.

Lube and oil service, air and fuel filter changes, and servicing of the injectors and turbochargers were the maintenance areas addressed in the questionnaire. Responses to cost of servicing were widely dispersed. Costs were divided about equally between parts and labor for most services and usually were higher for larger vehicles. Injector service was in general the most expensive ranging up to \$830 for parts and labor. However, turbocharger service was comparable for vehicles with GVWR over 33,000 pounds. Both fuel and filter changes generally cost less than \$50 for parts and labor, but were reported near \$100 for large tractors in two fleets. Several respondents indicated mileage of 50,000 to 100,000 miles or more between air filter services on large tractors and vans. This could contribute to higher emissions, if the air flow becomes partially blocked between changes.

Review of existing I/M programs in other states provided an indication of costs of operating programs, but heavy-duty diesel inspection activity, was rare and consisted of opacity tests only. In order to realistically test a diesel vehicle for the emissions of primary interest (oxides of nitrogen, hydrocarbons and particulates,) the engine must be

loaded, which usually requires a significant capital investment and more time per test than is customary for passenger vehicles. The large variety of heavy-duty diesel vehicle configurations further exacerbates the testing difficulty. A model I/M program for transit district and school buses is recommended as the next step in assessing the cost-benefit tradeoff of a heavy-duty diesel inspection program. Since they typically operate in highly populated air basins, have a duty cycle of many stops and starts, and constitute a readily identifiable group, evaluation of a model program for buses would be very informative. The capital and operational costs would be higher than for autos and therefore a pilot program for transit and school district buses is recommended, as a means of validating costs and benefits in an urban area, such as the South Coast Basin. The cost per vehicle for inspection could be expected to be in the 12 to 15 dollar range, but the cost of needed repairs might be high and difficult for owners to accept, especially for older vehicles.

Alternatively, visual inspection of components is not generally revealing and opacity tests at idle or higher rpm without loading could be expected to identify only the very worst emitters of particulates. An opacity test with the vehicle loaded is somewhat better, but will miss many vehicles emitting excessive oxides of nitrogen or carbon monoxide.

While not as numerous as diesel tractors, urban buses may produce an important contribution of pollutants for several reasons:

- (1) They operate daily within densely populated areas, which may already have high pollution levels.
- (2) Their duty cycle of many stops and starts is likely to produce higher emission rates than other diesel vehicles.
- (3) Many school and transit district buses are old and in some instances major engine maintenance may be postponed until absolutely necessary, or the vehicle is sold.

This group of vehicles is easily identified (small number of large fleets) and therefore may be easier to study.

Although not specifically addressed by this study, fuel quality, including the presence of water at the time of injection into the engine, could be a very important factor in reducing emissions statewide.

This reduction comes about through reduced release of contaminants at the time of combustion and, in the longer run, through reduced erosion of the injector nozzles. The hygroscopic nature of diesel fuel makes water content an important parameter of fuel quality. Additionally, the quality of fuel supplies is generally expected to deteriorate in coming years. Requirements on fuel quality at distribution points and/or fuel filtering systems on vehicles could alleviate this problem, and may be the most cost-effective measure for reducing HDDV emissions in the State.